The Pennsylvania Phosphorus Index: Version 1

Water Quality and Phosphorus

There has been increased attention focused on phosphorus (P) management because of water quality concerns resulting from eutrophication. In fresh water systems, elevated P inputs can lead to accelerated eutrophication and degraded water quality. Despite water quality concerns, adequate levels of soil P must be maintained to promote optimal crop production. Therefore, management options for P must be flexible addressing agronomic concerns while providing water quality protection.

The Phosphorus Index

The P index is a field evaluation tool that was developed to identify areas that have a high vulnerability or risk of P loss to surface water bodies. This tool combines indictors of P sources and of P transport. The P source indicators used in the Pennsylvania P Index are: Mehlich –3 soil test P, fertilizer application rate and method, and manure application rate, method and P availability. The transport indicators used are: erosion, runoff potential, sub-surface drainage, distance to a water body, and an evaluation of management practices that impact how P is potentially lost from a field.

The approach to using the P Index is to develop an N-based nutrient management plan and then evaluate this plan using the P Index in the centerfold of this fact sheet. Following is a brief description of each factor and the information needed for each factor's determination.

PART A:

If a field has **EITHER** a soil test P level greater than 200 ppm P (Mehlich-3) **OR** is closer than 150 ft. to a receiving body of water, as measured from the lower edge of the field, then continue to evaluate the field using Part B. If neither of these criteria applies, the N-based plan is acceptable as written.

PART B:

Source Factors:

Soil test level - taken directly from the soil test report

Fertilizer rates, methods, and timing of application - taken directly from the N-based nutrient management plan.

Manure rates, methods, and timing of application and P availability - taken directly from the N-based nutrient management plan. Availability varies with the type of manure or biosolid and is determined using Table 1of this fact sheet.

The source factor is determined by summing up these factors:

Source Factor = (Soil Test Rating + Fertilizer Rating + Manure Rating)

Transport Factors:

Erosion - the calculated soil erosion, using RUSLE, taken directly from a farm conservation plan.

Runoff potential - based on the soil type and can be determined using tables provided by USDA-NRCS regional nutrient management coordinators (see Contacts for Additional Information).

Subsurface drainage - based on whether or not there is artificial drainage in the field or if the field is near a steam and has rapidly permeable soils. "Random" drainage is a single or a few tile lines in a field and "Patterned" drainage is when most or the entire field is drained with a full patterned drainage system.

Contributing distance - the distance to a stream or other water body from the lower edge of the field. Choose the distance category in the P Index that contains the majority of the edge of the field.

Modified Connectivity – accounts for management practices that modify P transport. If the field is within 150 ft of water and a riparian buffer is present, select appropriate Modified Connectivity factor (i.e., reduces transport value). If a field is more than 150 ft from water but a direct connection, such as a pipe or ditch from field to water is present, select appropriate Modified Connectivity factor (i.e., increases transport value).

The transport factor is determined by first adding the transport factors together, then dividing by 22. The Modified Connectivity is multiplied by this value to obtain the final Transport Factor.

Transport Factor = ((Soil Erosion + Runoff Potential + Sub-Surface Drainage + Contributing Distance)/22) x Modified Connectivity

P INDEX VALUE

The P Index Value is calculated by multiplying the Source Factor by the Transport Factor and then multiplying the product by 2.

P Index Value = (Source Factor x Transport Factor) x 2

Interpretations and management guidance for the P Index value are given in Table 2.

Table 1. Organic P source availability coefficients*

Swine	
Swine slurry	1.0
Poultry	
Broiler	0.8
Layer	0.9
Turkey	0.9
Duck	0.9
Dairy	
Liquid	0.9
Bedded pack	0.8
Beef	0.8
Alum treated	0.5
Biosoilds	
Biological nutrient removal	0.8
Alkaline stabilized	0.4
Conventionally stabilized	0.3
Composted	0.3
Heat-dried	0.2
Advanced-alkaline stabilized	0.2

* Check for Table 1 updates in spring 2003 at panutrientmgmy.cas.psu.edu/

Following is the Pennsylvania P Index and worksheet that can be used to evaluate a number of fields. The interpretation and management guidance follows the P Index (Table 2).

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Version 1.

USER'S NOTE

If a field has a soil test level greater than 200 ppm Mehlich-3 P

OR

is within 150 feet of a water body then continue with **PART B**.

PART A	**Evaluation Category**
Soil Test Mehlich-3 P	Greater than 200 ppm P
Contributing Distance	Less than 150 ft

PART B

SOURCE FACTORS

SOIL TEST	Soil Test P (ppm Mehlich-3 P)				
	Soil Test Rating = 0.20 x Soil Test P (ppm Mehlich-3 P)				
FERTILIZER RATE	Fertilizer P (lb P_2O_5/acre)				
FERTILIZER APPLICATION METHOD	0.2 Placed or injected 2" or more deep	0.4 Incorporated in less than 1 week	0.6 Incorporated> 1 week or not incorporated April to October	0.8 Incorporated > 1 week or not incorporated Nov. to March	1.0 Surface applied during frozen or snow covered conditions
	Fertilizer Rating = Rate x Method				
MANURE RATE	Manure P (lb P_2O_5/acre)				
MANURE APPLICATION METHOD	0.2 Placed or injected 2" or more deep	0.4 Incorporated in less than 1 week	0.6 Incorporated after 1 week or not incorporated April to October	0.8 Incorporated > 1 week or not incorporated Nov. to March	1.0 Surface applied during frozen or snow covered conditions
MANURE P AVAILABILITY	Refer to Table 2: Organic Phosphorus Source Availability Coefficients				
	Manure Rating = Rate x Method x Availability				
	Source Factor = Soil Test Rating + Fertilizer Rating + Manure Rating				

TRANSPORT FACTORS

EROSION	Soil Loss (ton/acre/year)				
RUNOFF POTENTIAL	0 Very Low	2 Low	4 Medium	6 High	8 V. High
SUB-SURFACE DRAINAGE	0 None		1 Random		2** Patterned
CONTRIBUTING DISTANCE	0 > 500 ft.	2 500 to 350 ft.	4 350 to 250 ft.	6 150 to 250 ft.	8 < 150 ft.
	Transport Sum = Erosion + Runoff Potential + Sub-Surface Drainage + Contributing Distance				
					Transport Sum / 22
MODIFIED CONNECTIVITY	0.7 Riparian Buffer *Applies to distances < 150 ft.*		1.0 Grassed Waterway **OR** None		1.1 Direct Connection *Applies to distances > 150 ft.*
	Transport Factor= Modified Connectivity x (Transport Sum / 22)				
	Phosphorus Index Value = 2 x Source Factor x Transport Factor				

** OR a rapid permeability soil near a stream

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PART A – SCREENING TOOL

Field ID											
Soil test P											
Contributing distance											

PART B - SOURCE FACTORS

Soil test P											
Soil Test Rating											
Fertilizer rate											
Fertilizer application method											
Fertilizer Rating											
Manure rate											
Manure application method											
Manure P availability											
Manure Rating											
Source Factor											

TRANSPORT FACTORS

Erosion											
Runoff potential											
Subsurface drainage											
Contributing distance											
Transport Sum											
Transport Sum / 22											
Modified connectivity											
Transport Factor											
P Index Value											

Table 2: Phosphorus index management guidance.

Value	Rating	Management Guidance
0 to 59	Low	**Nutrients can be applied to meet the Nitrogen crop requirement.** *Low* potential for P loss. Maintenance of current farming practices is recommended to minimize the risk of adverse impacts on surface waters
60 to 79	Medium	**Nutrients can be applied to meet the Nitrogen crop requirement.** *Medium* potential for P loss. The chance for adverse impacts on surface waters exists. An assessment of current farm nutrient management and conservation practices is recommended to minimize the risk of future P losses.
80 to 99	High	**Nutrients can be applied to meet the Phosphorus crop removal.** *High* potential for P loss and adverse impacts on surface waters. Soil and water conservation measures and P-based management plans are needed to minimize the risk of P loss.
100 or greater	Very High	**No Phosphorus can be applied.** *Very high* potential for P loss and adverse impacts on surface waters. Conservation measures and a P-based management plan must be implemented to minimize the P loss.

These interpretations give general guidance for management based on the P Index. However, it is important to not only look at the final index rating, but if the rating is *High* or *Very High* to go back to the P Index and determine why. Often management changes other than simply limited or no manure application can lower the P Index to an acceptable level that would allow manure application and provide water quality protection. Examples may include establishing best management practices (BMPs) to reduce soil erosion, or changing the timing or method of manure or fertilizer application. Also, if the P Index rating is in the *Medium* category be aware that continued N-based manure application rates will likely increase the P Index rating and may result in *High* or *Very High* P Index ratings in the future.

The application of the Phosphorus Index in Pennsylvania

Currently, USDA-NRCS in Pennsylvania requires P-based plans developed using the P Index described in this fact sheet. This requirement is a part of the Practice Standard 590 – Nutrient Management and impacts agricultural operators **receiving technical or financial assistance for manure related issues.**

Information resources for the Phosphorus Index

Publication references:

Sharpley, A. and D. Beegle. 2001. Managing phosphorus for agriculture and the environment. The Pennsylvania State University, Publications Distribution Center, University Park, PA 15 pp.

Sharpley, A.N., T. Daniel, T. Sims, J. Lemunyon, R. Stevens, and R. Parry. 1999. Agricultural phosphorus and eutrophication. U.S. Department of Agriculture, Agricultural Research Service, ARS-149, 42 pp. www.soil.ncsu.edu/sera17/publications/AgP&Eutro/agricultural_phosphorus_and_eutr.htm

Web site references:

The Pennsylvania Nutrient Management Program.

This site provides a comprehensive source of information about Pennsylvania's Nutrient Management Program, and associated technical guidance and educational information.

panutrientmgmt.cas.psu.edu/

The National Phosphorus Research Project.

This site provides a national perspective and on P research, management, and P Index development.

pswmru.arsup.psu.edu/phosphorus/nprp.htm

Pennsylvania P Index Version 1 Developers

The following scientists developed the Pennsylvania P Index Version 1 and serve as resources for additional information:

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USDA-NRCS Regional Nutrient Management Coordinators
panutrientmgmt.cas.psu.edu/pdf/nrcs_nm_field_team_coordinators.pdf

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